Area-Wide
Soil Contamination

Area-Wide Soil Contamination Project

Working Definition Moderate Levels of Lead

Prepared for

MTCA Science Advisory Board

January 12, 2004

Area-Wide

Soil Contamination

Task Force Recommendation Tiered Approach

High

- Traditional Cleanup Processes and Measures (e.g. removal & containment)
- Institutional Controls and Periodic Review

Moderate

- Broad-Based Education and Awareness Building
  - Individual Protection Measures
  - Simple Containment Measures
- Containment measures integrated with new construction/renovations
- Periodic Program Review

Low

- No Further Actions

Moderate Levels of Lead Ecology Working Definition

	Lower End of Range	Upper End of Range
Residential Areas	250 mg/kg	500 mg/kg
Schools & Child Care Facilities	250 mg/kg	700 mg/kg
Commercial Facilities & Parks	250 mg/kg	1000 mg/kg

Current Situation

- Lead exposure can cause a wide range of health problems
  - State and federal agencies currently consider a blood lead level > 10 ug/dL to be elevated.
  - Recent scientific studies indicate that low level exposure (< 10 ug/dL) may be more problematic than previously thought
- Soil testing indicates that lead levels in many areas have the potential to cause blood lead levels > 10 ug/dL
- Child blood lead screening (0-6 years old):
  - 1.2 % of WA children tested in 2002 found to have blood lead levels > 10 ug/dL
  - 6.8% of WA children found to have blood lead levels > 5 ug/dL

Elevated Lead Exposures Can Cause Health Problems

- Small children are most sensitive to elevated lead exposures
  - Critical effect = CNS effects (including learning, development, vision, etc.)
  - Other health effects include anemia, kidney damage, muscle weakness, etc.
- Adults may experience a wide range of health effects
  - Critical effect = CNS effects in developing fetus and neonates
  - Other health effects include adult CNS and PNS effects, hypertension, reproductive effects, etc.

Health Agencies Consider PbB Levels > 10 ug/dL to be Elevated

- < 10 ug/dL - Retest in 1 year. No additional action
- 10-14 ug/dL - Family Lead Education/Followup Testing
- 15-19 ug/dL - Education/followup testing (if blood Pb levels persist/worsen - proceed with coordination of care, case management, environmental investigation and remediation
- 20-44 ug/dL - Case management, clinical management, environ. investigations & remediation
- 45 - 69 ug/dL - Within 48 hours begin case management, etc.
- >70 ug/dL - Hospitalize child & begin medical treatment.

PbB levels < 10 ug/dL may pose greater risks than previously estimated

- Canfield et al. have reported adverse effects among children with blood levels < 10 ug/dL
- Reduced IQ scores are surrogate measure for neurological effects
- Key findings:
  - Reduced IQ scores associated with elevated lead exposure even when exposures are < 10 ug/dL
  - Effects of lead exposure are proportionately greater at lower PbB levels (<10 ug/dL)

Soil lead levels can be high enough to increase the chances that a child will have PbB levels > 10 ug/dL

- MTCA Method A cleanup level (250 mg/kg) is based on preventing PbB levels above 10 ug/dL
- Median lead levels found in WA studies range from 11 to 220 mg/kg.
- 90th percentile lead levels found in WA studies range from 66 to 860 mg/kg.

Blood Lead Testing

- Blood lead levels in children have steadily decline over the last 20 years.
- 1.2% of WA children tested in 2002 had blood lead levels > 10 ug/dL
- 6.8% of WA children tested in 2002 had blood lead levels > 5 ug/dL
- Substantial variation in levels and participation across the state.

Process To Develop the Working Definition Involved Several Steps

- Interim Action Criteria for Child Use Areas on Maury & Vashon Islands (2001)
- Application to Child Use Areas in Other Parts of Washington (2002-present)
- Landau Associates Health and Ecological Assessment (2002)
- Working Definition (April 2003)
- Updated Technical Analysis (Dec. 2003)

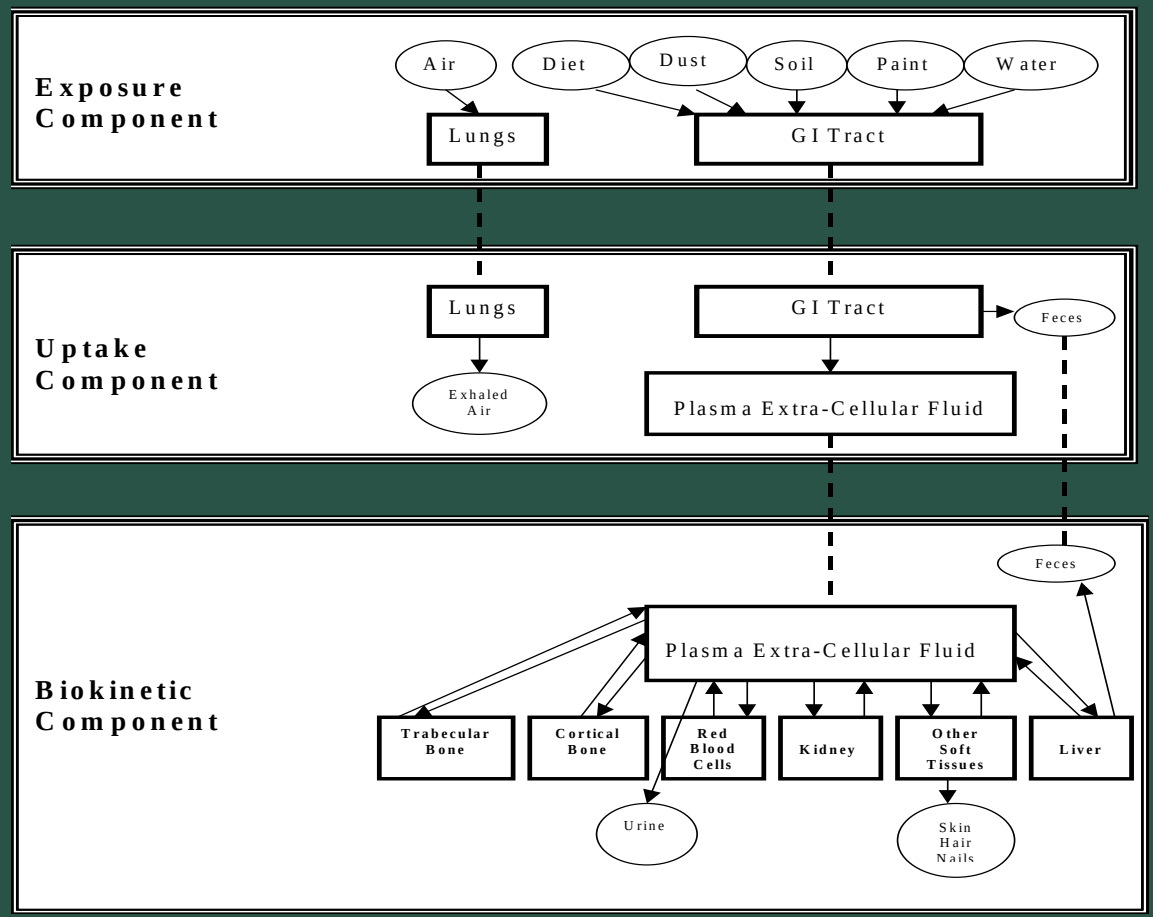
Assumptions

- Ground water unlikely to be impacted at soil concentrations below 1000 mg/kg
- Major contributors to lead exposure include soil/dust ingestion, food and drinking water
- EPA lead exposure models are sound methods for evaluating health risks
- Use of CDC Blood Lead Screening Guidelines
- Consideration of ecological impacts during property development and renovations
- Future review and update based on new information

General Approach

- lEUBK Model used to evaluate health risks associated with children's exposure to lead-contaminated soils
- EPA Adult Lead Model used to evaluate health risks associated with adult exposure to lead contaminated soils.

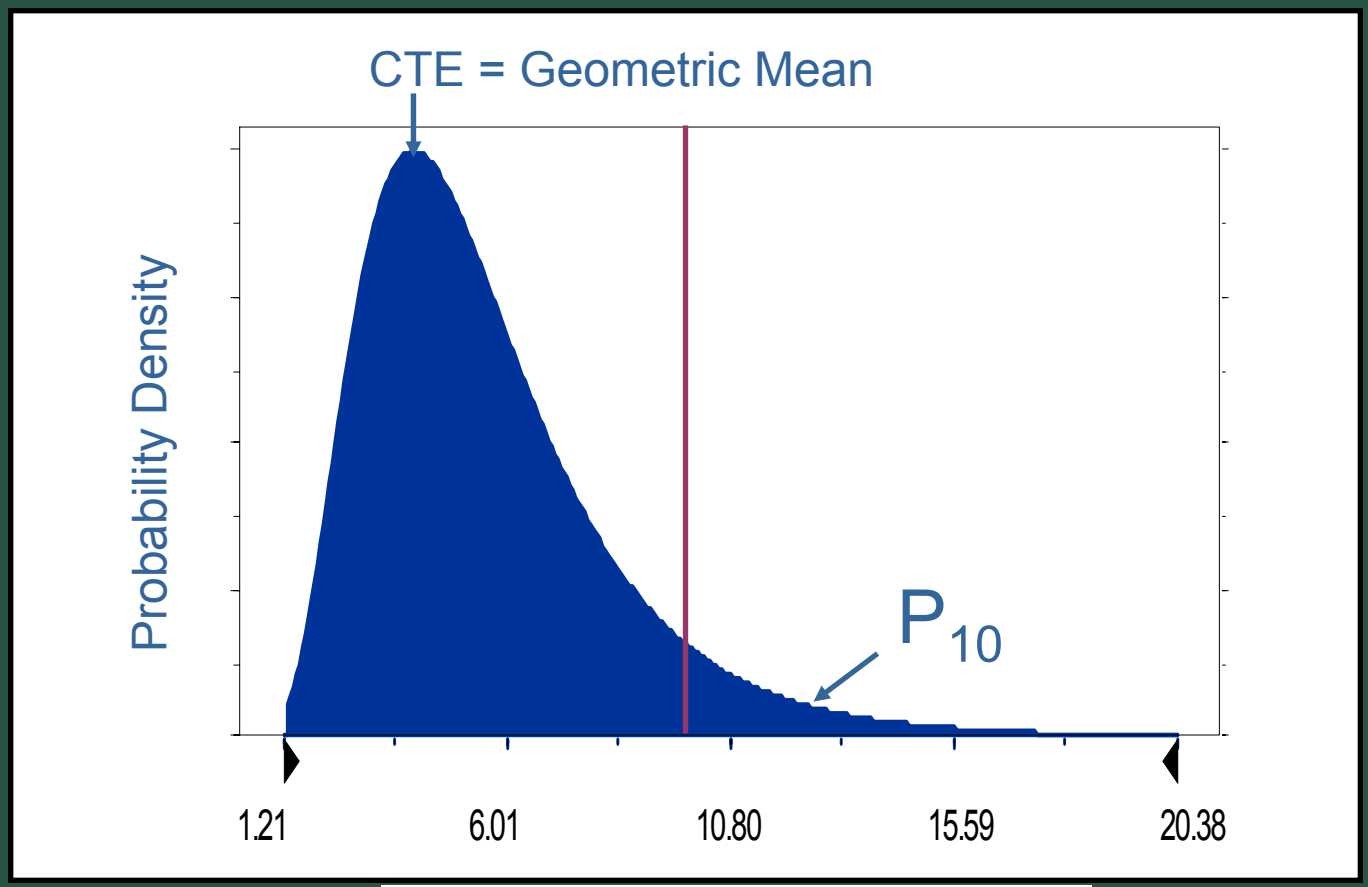
IEUBK Model


Exposure Component
Air
Diet
Dust
Soil
Paint
Water
Lungs
GI Tract
Uptake Component
Lungs
GI Tract
Feces
Exhaled Air
Plasma Extra-Cellular Fluid
Biokinetic Component
Feces
Plasma Extra-Cellular Fluid
Trabecular Bone
Cortical Bone
Red Blood Cells
Kidney
Other Soft Tissues
Liver
Urine
Skin Hair Nails

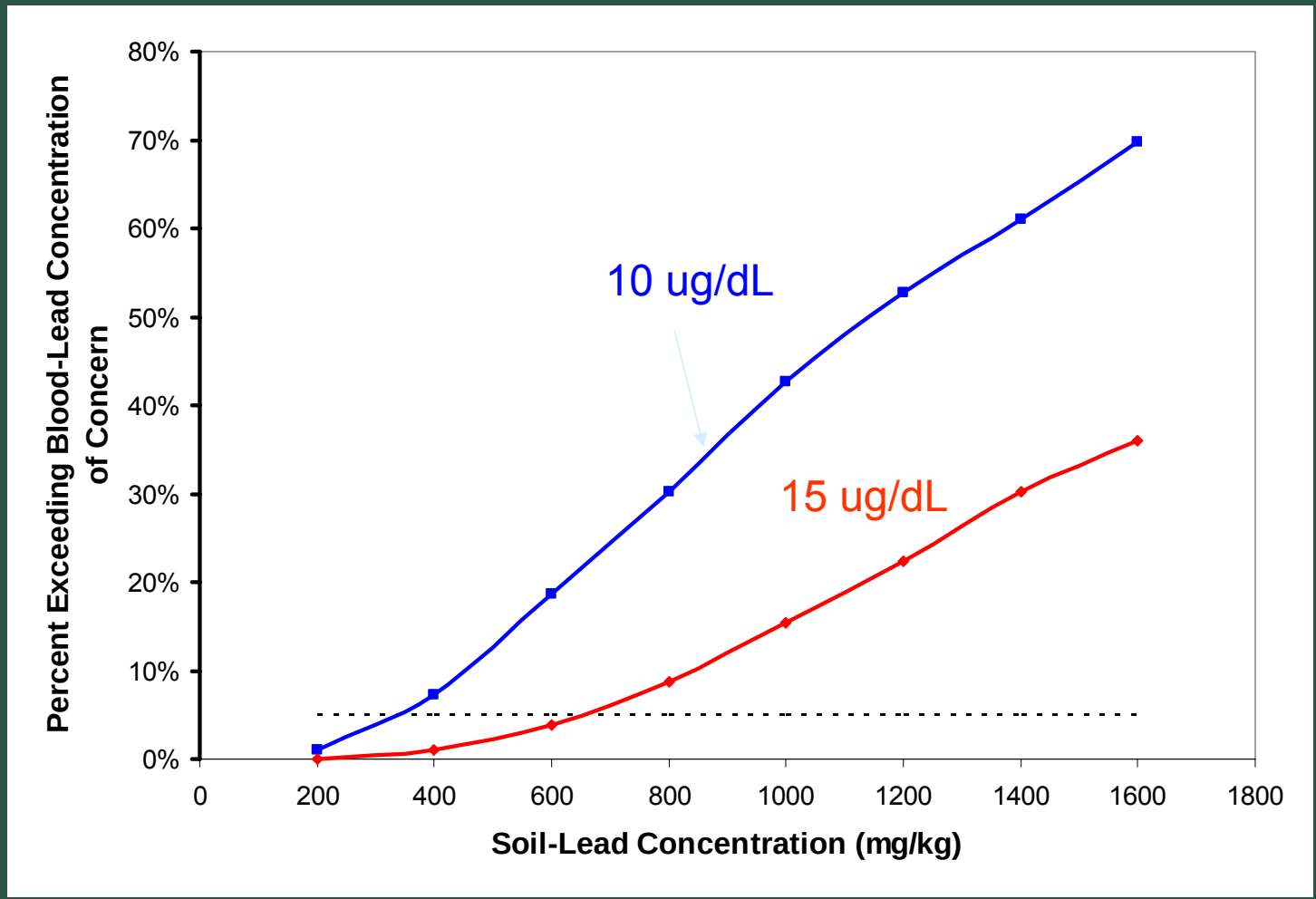
Model Assumptions

- PbB_{child} can be estimated as a sum of an expected starting point PbB level and expected increases due to lead exposure from several environmental media.
- Lead uptake from soils can be estimated using soil lead concentrations, estimates of daily soil/dust ingestion and fractional absorption of lead.
- Lognormal model can be used to estimate inter-individual variability in PbB_{child}
- PbB levels are an appropriate indicator of health effects
- CDC Guidelines define appropriate levels of concern

Terminology



Soil-Blood Lead Relationships



Results

Table 5.1 P_{10} and P_{15} Predicted by the IEUBK Model for Different Combinations of Soil Concentrations and Land Uses

Soil Concentration	Age Interval (months)	Residential Areas		Schools/Child Care Facilities		Commercial Facilities & Parks	
		P_{10}	P_{15}	P_{10}	P_{15}	P_{10}	P_{15}
250 mg/kg	0-84	1.0%	< 0.1%	0.3%	< 0.1%	< 0.1%	< 0.1%
	12-36	5.0%	0.3%	0.8%	< 0.1%	< 0.1%	< 0.1%
500 mg/kg	0-84	9.6%	1.5%	3.4%	0.4%	0.1%	< 0.1%
	12-36	21.3%	4.9%	7.9%	1.2%	0.3%	< 0.1%
700 mg/kg	0-84	22%	5.1%	9.5%	1.5%	0.4%	< 0.1%
	12-36	39.5%	12.9%	18.9%	4.1%	1.1%	< 0.1%
1000 mg/kg	0-84	41.7%	14.2%	22.7%	5.4%	1.5%	0.1%
	12-36	61.2%	28.1%	37.6%	11.9%	4.0%	0.5%

Variability and Uncertainty

- Amount of soil-related lead intake and uptake into the bloodstream
- Relationship between soil lead uptake and changes in blood lead concentrations
- Relationship between blood lead concentrations and adverse health effects
- Amount of non-soil lead exposure

Child Lead Exposure Summary

- IEUBK model predicts there is a 1-5% probability that exposure to soil concentrations of 250 mg/kg will result in PbB > 10 ug/dL
- IEUBK model predicts there is a 1-5% probability that exposure to soil concentrations of 500 mg/kg will result in PbB > 15 ug/dL
- Reduced exposure frequency results in lower predicted probabilities of elevated PbB levels (> 10 ug/dL or > 15 ug/dL)
- Several sources of variability and uncertainty complicate interpretation of modeling results

Adult Lead Model

PRG = Preliminary Remediation Goal

$$PRG = \frac{(\Delta\ PbB_{maternal})}{(\text{BioKinetic Slope Factor})(\text{Intake Factor})}$$

$$PRG = \frac{([PbB_{95\,fetal}/(R_{r/m} * (GSD^{1.645}))]) - PbB_{adult,o}) * AT}{BKSF * (IR_s * AF_s * EF_s)}$$

Model Assumptions

- $PbB_{maternal}$ can be estimated as a sum of an expected starting point PbB level (baseline) and an expected site-related increase.
- Site-related increase in $PbB_{maternal}$ can be estimated using a linear biokinetic slope factor
- Lognormal model can be used to estimate inter-individual variability in $PbB_{maternal}$
- Expected PbB_{fetal} are proportional to $PbB_{maternal}$
- CDC Guidelines define appropriate levels of concern
- Protective of other health effects

Results

Table 4.1: Comparison of PRGs Calculated with the EPA Adult Lead Model		
	IR_s = 0.05	**IR_s = 0.10**
West Region (all women of child-bearing age)	**1300 mg/kg**	**650 mg/kg**
All Regions (Mexican-American women)	**800 mg/kg**	**400 mg/kg**
All Regions (non-Hispanic black women)	**940 mg/kg**	**470 mg/kg**
All Regions (non-Hispanic white women)	**1280 mg/kg**	**640 mg/kg**
All Regions (women ages 17-25 years)	**1460 mg/kg**	**730 mg/kg**
All Regions (women ages 26-35 years)	**1250 mg/kg**	**625 mg/kg**
All Regions (women ages 36-45 years)	**1050 mg/kg**	**525 mg/kg**

Adult Lead Exposure Summary

- The ALM predicts a PRG of 800 mg/kg using the EPA default exposure parameters with regional information on maternal blood lead concentrations.
- Use of alternate exposure assumptions results in PRG values that range from 400 to 1460 mg/kg.
- PRG values predicted by the Adult Lead Model are generally higher than soil concentrations associated with P_{10} values above 5% that are predicted by the IEUBK model.

Moderate Levels of Lead Ecology Working Definition

	Lower End of Range	Upper End of Range
Residential Areas	250 mg/kg	500 mg/kg
Schools & Child Care Facilities	250 mg/kg	700 mg/kg
Commercial Facilities & Parks	250 mg/kg	1000 mg/kg

Key Policy Choices

- Use of PbB = 10 ug/dL to define lower end of the range
- Use of PbB = 15 ug/dL to define upper end of the range
- Probability of exceedances = 1-5%
- Consideration of current land uses
- Consideration of ecological impacts during property development/redevelopment

Technical and Policy Rationale

- Primary Considerations:
  - Health Risks
  - Uncertainty and Variability
  - Consistency with MTCA
- Other Considerations:
  - Implementation
  - Consistency with Current Practice
  - Consistency with Other States

Science Advisory Board Review

- Information: *Do the materials provide a sufficient amount of information? If not, what additional material would be useful?*
- List of Questions: *Are there additional questions you believe the Department should be considering when evaluating this issue?*
- Review Process: *What type of review process does the Board believe should be used on this issue?*

Area-Wide
Soil Contamination

Next Steps

- Complete and Mail Additional Materials
  - Appendices A-E
  - Arsenic Materials
  - Other Information Identified by Board
- SAB Meeting in Late March (based on January 12 discussion)
- Meet with EPA staff and others to discuss issue